POWER FOR GOOD

Steeple Renewables Project

Appendix 2.2 - Phase 1 Geoenvironmental Desk Study

Environmental Statement - Volume 2 January 2026

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Appendix 2.2 - Phase 1 Geoenvironmental Desk Study

Environmental Statement - Volume 2

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Phase 1 Geoenvironmental Desk Study

Land Near Sturton-le-Steeple

for

Renewable Energy Systems Limited

G-24-030

December 2025

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Executive Summary

Site Location	**West** proposed Solar PV Areas, Bio Mitigation and Cable/Access Routes covers an area of c. 450ha, Centre NGR 477076 383414. **East** proposed Solar PV Areas, Bio Mitigation, Cable/Access Routes and BESS covers an area of c. 443ha. Centre NGR 480487 383614
Site Description	**West:** arable farmland with a network of access tracks and drains on gently undulating ridges and valleys with streams flowing west to east/north-east. Ground levels fall from 68m AOD on West side to 14m AOD on East. Small areas of mature deciduous woodland and one small orchard area. Access routes generally following existing access roads/tracks. **East**: flat and level with most of site lying at between 3 and 5m AOD rising to c.7m AOD in BESS. Predominantly arable farmland, some recently ploughed at time of walkover. Network of roads/access tracks with significant drainage channels with smaller drainage ditches. Small areas of mature deciduous woodland. Access routes generally following existing access roads/tracks. **West Burton Power Station:** Access was not made to West Burton Power Station at the time of the walkover survey.
Site History	**Based on OS Mapping from 1885 to present:** **West:** arable farmland with some small areas of woodland. Site dissected by Lincoln to Sheffield railway line throughout. A number of springs and wells are shown on the historical maps. No significant changes over period. **East:** arable farmland with Littleborough Road ("Roman Road") traversing ESE to WSW through site. No significant changes over period. Overhead HV electricity cables on pylons and 2 No. buried oil pipelines running NW-SE. NB*: Roman settlement of Segelocum and Medieval Village of West Burton in proximity to the site, but are outwith the boundaries of the site.* **West Burton Power Station:** developed in 1960s (shown on maps from 1971) **Flood plain of River Trent:** "Towing path" for barges navigating river shown from 1885. Flood defences (flood bank) present from 1975. Large pond shown from same time, possible borrow pit for embankment.
Geology	No geologic faults on site. The site is not affected by coal mining, brine or other mineral extraction. **West:** West of Sturton-le-Steeple, majority of the site is directly underlain by weathered bedrock comprising mudstones with beds of dolomitic siltstone and possible gypsum beds of Mercia Mudstone Group of early Triassic Age. Anticipated ground conditions are a thin cover of topsoil/subsoil (<0.5m) over

	weathered mudstone bedrock and locally more resilient dolomitic siltstone beds. No quarrying of bedrock in the site area however clay pits relating to brick manufacture previously existed adjacent to the site. **East:** East of Sturton-le-Steeple, site underlain by variable thicknesses of superficial deposits including alluvium, river terrace deposits and Glacial Till. Anticipated ground conditions are a thin cover of topsoil/subsoil (<0.5m) over silty sands, sandy clays and sands and gravels to depths of between 4.5m and 16m based on a limited number of boreholes. Bedrock comprises Mudstones of the Mercia Mudstone Group.
Environmental	**West:** Superficial deposits are a Secondary Undifferentiated Aquifer. Mercia Mudstone bedrock is a Secondary B Aquifer with dolomitic siltstones classed as Secondary Undifferentiated Aquifer. Groundwater vulnerability records indicate superficial aquifer and productive bedrock aquifer with well connected fractures of high vulnerability. • Low possibility of natural subsidence or dissolution of bedrock. • 9 Nitrate Vulnerable Zones within 2000m, 2 of which are on-site. • No. licensed surface water or groundwater abstractions within 2000m. • The site is not within 500m of a source protection zone. • 3 No. discharge consents to controlled waters relate to High Sturton House which lies outside the actual site. • No pollution incidents recorded within 500m of the site. **East**: superficial deposits are a Secondary A Aquifer. Mercia Mudstone bedrock is Secondary B Aquifer. Groundwater vulnerability records indicate superficial aquifer and productive bedrock aquifer with well connected fractures of high vulnerability. • Negligible risk localised of subsidence or dissolution of bedrock. • 9 Nitrate Vulnerable Zones within 2000m, 3 of which are on-site. • 1 No. historical licensed surface water abstraction on site. • The site is not within 500m of a source protection zone. • 1 No. discharge consent to controlled waters, sewage discharge to a ditch. • No pollution incidents recorded within the site area.
Flooding	A flood risk analysis is being undertaken by others and is therefore outwith the scope of this report.
Contamination	No potential significant contaminative processes have operated on the majority of the site (Greenfield areas are 99% of land area). The following low level diffuse contaminants may exist on the farmland areas: polyaromatic hydrocarbons (PAHs), soluble sulphates, chloride, ammoniacal compounds and

	nitrogenous derivatives, metals and metalloids, hydrocarbons and PFAS (per- and polyflouralkylated substances). High natural sulphate and chlorine contents may be anticipated within the weathered Mercia Mudstone. The following contaminants of concern may be anticipated in brownfield areas (1% of land area) occupied by farm buildings, railway lines, West Burton Power Station and oil pipelines: PAHs, heavy metals, water soluble sulphates, fuel, grease, lubricating oil, heating oil, gas oil, asbestos, biocides, PCBs and transformer oils.
Ground Gas	Radon protective measures are not required for buildings in this area. Ground gases are not considered to pose a risk to the development.
Drainage	The mudstone bedrock is unlikely to be suitable for soakaway drainage systems on the West side of the site and within the BESS. Surface water drainage to the alluvial deposits East of Sturton-le-Steeple will need to be assessed, bearing in mind the very low-lying land and the high-water table present in this area. Proposed infiltrating surface water attenuation basins and/or soakaway drainage systems should be situated >5m from foundations of any structures.
Recommendations for Ground Investigation	Ground investigation will be required prior to development for engineering design, however, as the site is greenfield of low overall contamination risk, this is not considered necessary prior to grant of planning. Phased targeted ground investigation to include: • Intrusive ground investigation to c. 5m depth with in-situ testing and sampling of soils, groundwater and surface water, as necessary. • Trial pitting for in-situ testing (hand shear vanes and CBRs), sampling and rock mass assessment. • Infiltration testing to assess suitability for soakaway drainage. • Geotechnical laboratory testing of the soils to assess the physical and geochemical properties for foundation design. • Chemical laboratory testing of the soils and controlled waters and risk assessment against industrial/commercial end-use criteria to allow development of the CSM. • Factual and interpretive report, providing recommendations for remedial actions as required to allow the safe development of the site.

The executive summary should not be read or used in isolation and reference should be made to the full report which provides a detailed assessment of the risks potentially affecting the development.

1.0 Introduction

1.1 Commission

GVR Geoservices Ltd (GVR Geo) was appointed by Renewable Energy Systems Ltd (RES) to undertake a Phase 1 Geoenvironmental Desk Study for the proposed development of a Photo-Voltaic (PV) Solar Array, Battery Electrical Storage System (BESS), associated cabling routes and other infrastructure together with areas of environmental mitigation on the East side near the River Trent and to the West in the vicinity of Sturton High House farm.

The scope of works of this study includes:

- Purchase of Groundsure Insight report (Historic Mapping, Enviro+Geo Insight and Geological database);
- Review land use history, hydrology, geology and hydrogeology;
- Undertake a geoenvironmental site walkover survey;
- Conceptual site model in line with current best practice Land contamination: risk management' (LCRM, Environment Agency, 2022) and 'Guidance for the Safe development of Housing on Land Affected by Contamination' (R&D Publication 66: 2008);
- Provide a factual and interpretive report with recommendations for scope of further investigations.

A site location plan is presented as Drawing No. G-24-030-001 in Appendix A.

1.2 Proposals

It is understood that a Solar PV Array with associated infrastructure including a BESS is proposed to be constructed on areas of land East and West of Sturton-le-Steeple, near Retford in Nottinghamshire.

This report is required to support the planning application. Copies of the proposed concept layout, RES Dwg. No. 04954-RES-LAY-DR-LE-018, Rev. 2.1, Indicative Parameters Plan, Draft11.11.24 and RES Dwg. No. 04954-RES-LAY-DR-PT-010, Rev. 3, 2.35 - Cable Crossing Plan SPFP REG 5(2)(O)are provided in Appendix A.

1.3 Objectives

The objectives of this report are as follows:

- Conduct a site walkover survey of the land to look for evidence of potential land contamination.

- Assess the land use history and whether the site had previously been used for a purpose that may have given rise to significant ground contamination that could affect the development.
- Provide information on ground conditions, including the potential for surface or underground mineral or brine extraction.
- Describe the environmental setting of the site and status of environmental receptors.
- Assess the potential for hazardous ground gas to affect the proposed end use.
- Provide a conceptual site model to allow a preliminary environmental risk assessment.
- A flood risk analysis is being undertaken by others and is therefore outwith the scope of this report.
- Inform the need for and scope of further assessment works.

This report presents factual information obtained during this appraisal, an interpretation of the data and recommendations with respect to the proposed development.

1.4 Sources of Information

The study includes a review of the following information sources and references:

1. Groundsure Insight report which includes but is not restricted to: historical OS maps and land use, geology, hydrogeology, hydrology, environmental receptor search data, past and present landfill and waste management, hazardous substances, industrial land use, and sensitive land uses.
2. British Geological Survey (BGS) GeoIndex online search tool.
3. BGS Regional Memoirs, where applicable.
4. Defra MAGIC online map viewer.
5. Geological Memoir: East Retford, Worksop and Gainsborough. Memoir for sheet E101 Geological Survey of Great Britain). Smith, E.G. ISBN 0118805908 Sheet(s) Covered E101, 1973.
6. Segelocum Roman town https://historicengland.org.uk/listing/the-list/list-entry/1003669.
7. West Burton - Medieval settlement and open field system immediately south east of Low Farm **https://historicengland.org.uk/listing/the-list/list-entry/1017741**
8. Environment Agency (2018) The Environment Agency's approach to groundwater protection. February 2018, version 1.2.

1.5 Limitations

This report has been prepared for the sole use of RES, and their appointed agents only and should not be relied upon by any third party without the written permission of GVR Geo. If

any unauthorised third party comes into possession of this report, they rely on it at their own risk and the authors do not owe them any Duty of Care or Skill. This report is based on and limited to an assessment of the information and ground conditions identified here. GVR Geo is not responsible for ground conditions not revealed during these investigations.

2.0 Site Setting

Due to the size and complexity of the site, the information has been summarised in terms of two mains areas, West and East (of Sturton-le-Steeple). The site is further subdivided, where necessary, based on the proposed end-use of these areas based on Fig. 1.2 Indicative Parameters Plan, RES Dwg. No. 0495-RES-LAY-DR-018 Rev. 2.1 (DRAFT 24.11.11) presented in Appendix A. Based on this drawing, the following future development areas are:

AREA LABEL	PURPOSE	NOTES
PV_ARR	Area for solar panels and associated development	
CAB_INF	Cable infrastructure	Includes land within West Burton Power Station
SS_BESS	Substation, BESS and associated Infrastructure	Includes land within West Burton Power Station
BIO_MIT	Bio diversity mitigation	
BIO_CAB	Bio diversity mitigation and cable Infrastructure	
ACC_CORR	Site access corridor	
RES_ACC	Reserve access route	Not shown on RES plan

A site walkover was carried out on Wednesday 6th November 2024. Notes from the walkover are included in the site setting descriptions below.

OS Grid Reference	Centre of Western Site Area NGR 477076 383414 Centre of Eastern Site Area NGR 480487 383614
Distance/Area	i) Western area including Solar PV Areas, Bio Mitigation and Cable/Access Routes covers an area of c. 450ha . ii) Eastern area including Solar PV Areas, Bio Mitigation, Cable/Access Routes and BESS covers an area of c. 443ha.
Location	Please see the Site Location Plan and Site Land Use Plans (see Dwg. Nos. G-24-030-001 and G-24-030-002 to 004 respectively for further details). The Western area is irregularly shaped between the Torksey Branch Railway Line, the village of North Leverton with Habblesthorpe to the South; Leverton Road to the East, skirting around west of Sturton-le-Steeple; Wheatley Road to the North, and along a line approximately 900m west of and parallel to the Sheffield to Lincoln railway line. A further parcel of land intended for Bio Mitigation, some 1.5km long by 600m wide, lies c.1.1km to 1.6km WNW of the Sheffield to Lincoln line, between Sturton High House and Clarborough Grange. The majority of the Eastern part of the site covers a roughly triangular area. The southern edge is formed by the district boundary between North Leverton with Habblesthorpe / Sturton-le-Steeple, west of North Leverton and extending east to the hamlet of Littleborough. The North Eastern boundary follows the overhead power lines from here to West Burton Power Station, then West to Gainsborough Road with part of the site within the curtilage of the existing power station. The Western boundary lies East of Sturton-le-Steeple and partially follows the line of the "Catchwater Drain" to Fenton. Approximately 11ha of the site lies within West Burton Power Station – a previously coal fired power station. This area has not been reviewed during the walkover. It is anticipated that the connections to the National Grid will be made in this area and will not significantly alter the use of this area. A portion of the site to be retained for Bio Mitigation occupies land on the West bank of the River Trent, North of Littleborough skirting around the Roman Settlement of Segelocum.

Description	**West** Generally, gently undulating ridges and valleys with streams flowing west to east/north-east. Ground levels of up to 68m AOD on west side near Sturton High House, falling to 14m AOD on West side of Sturton-le-Steeple with a gradient of approximately 1V:50H. Predominantly arable farmland, some recently ploughed at time of the walkover survey. Field boundaries are generally hedgerows and/or some ploughed soils red brown sandy clay with a little angular gravel of mudstone indicate weathering of underlying mudstone bedrock. Some undulating ground near Field Farm possibly indicative of underlying limestone. Well maintained access tracks, generally surfaced with river gravel, localised signs of rubble or road planings used and raised above adjacent field level generally. Drainage ditches adjacent to at least one side of most tracks. Well maintained hedgerows throughout. Small areas of mature deciduous woodland and one small orchard. Mature deciduous trees including oak trees present sporadically along track/field boundaries. No obvious signs of fly-tipping at time of visit. Farm access tracks are controlled by locked metal gates at several locations, all of which are large enough to permit access by farm machinery including combined harvesters etc. Access between the sections of site on either side of the Sheffield to Lincoln railway track requires the use of overbridges (Wheatley Road), level crossing (Freeman's Lane), or underpass (High House Road/Springs Lane). A height restriction sign was not observed on the underpass. Overhead power lines cross the south eastern boundaries near Keeper's Cottage/North Leverton and run north to the west side of Sturton-le-Steeple. These are presented indicatively on the site layout plans. **East** Generally flat and level with most of site lying at between 3m and 5m AOD. Predominantly arable farmland, some recently ploughed at time of the walkover survey. Apart from the main access roads such as Littleborough Road, there are well maintained side access tracks, generally surfaced with gravel and raised above adjacent field level. Significant drainage channels including Mother Drain and Catchwater Drain. Smaller drainage ditches

	adjacent to at least one side of most tracks. Well maintained hedgerows throughout. Small areas of mature deciduous woodland. Mature deciduous trees including oak trees present sporadically along track/field boundaries. No obvious signs of fly-tipping at time of visit. Farm access tracks are controlled by locked metal gates at several locations, all of which are large enough to permit access by farm machinery including combined harvesters etc. Access was not possible to West Barton Power Station and the fields immediately south of the power station at the time of the walkover survey. Bio-mitigation area adjacent to River Trent – access via Thornhill Lane or Littleborough Road through hamlet of Littleborough via lane with track onto riverbank. Rough unsurfaced tracks run on riverbank and flood bank. Large pond (see site history) with sluice drainage into River Trent present on flood plain area East of flood bank. BIO_MIT Areas 3-5 West of flood bank occupied by flat arable fields (generally ploughed at time of visit). The riverbank of the River Trent appears to be relatively stable. No distinct slope failures were visible, however the site visit was brief and overgrown areas were not reviewed in any detail. Several overhead power lines are present, generally running South-South East from the substation at West Burton Power Station across the proposed BESS and PV Array areas. Two buried oil pipelines, carrying presumed gas oil for boilers, cross the Eastern half of the site, generally trending North West-South East immediately West of the West Burton Power station cooling towers to the South East corner of the site at Littleborough where they cross the River Trent. The overheads are presented indicatively on the site layout plans and the pipelines on the Cable Crossing Plan in Appendix A.

Adjacent Land Use	**West** • North: Arable farmland with some residential properties adjacent to Wheatley Road. • East: Arable farmland with villages of North Leverton and Sturton-le-Steeple beyond. • South: Railway line on embankment with arable farmland beyond • West: Arable farmland. **East** • North: Arable farmland and West Burton Power Station with associated access roads. • East: Arable farmland with River Trent and associated river bank / flood defences beyond. • South: Arable farmland. • West: Villages of Fenton and Sturton-le-Steeple.

3.0 Geoenvironmental Information

Historical maps are included in Appendix B and environmental data is included in Appendix C.

3.1 Historical Land Use

A brief summary of the land use history of the site is presented below which is intended to only describe the changes that have occurred on or adjacent to the site that are relevant to the objectives of this investigation.

It should be noted that the available mapping, and the Ordnance Survey records specifically, are generally limited to the period from the late 19th century to the present day. In addition, Ordnance Survey mapping was, until recent times, carried out approximately every 20 years. Excavations, such as clay, sand or gravel pits, shallow mining and other short-term disturbance of the site may not therefore have been mapped.

WEST		
Dates	**On-Site**	**Off-Site**
1885/1886	Generally, site area is arable farmland with access road and drainage layout much as present day. Some small ponds and a number of wells shown across the area. Manchester Lincolnshire and Sheffield Railway (Lincoln to Retford Branch) on embankment forms southern boundary. Lincoln to Sheffield railway line present across centre of site.	North: Arable farmland. Brickworks north of Wheatley Road – clay pit immediately to north. East: Arable farmland with Village of Sturton-Steeple beyond. South: Railway line with arable farmland beyond. West: Arable farmland.
1920s	Field sizes increase due to removal of field boundaries. Increasing number of houses adjacent to Sturton-le-Steeple from 1920s onward.	Former brickworks now shown as a residential property “The Poplars”.
1960s/1970s	No significant changes. Building, possibly a large barn north west of Leverton from 1968 (within Cable Access route). Field Farm buildings removed and replaced with current buildings (1973). Access roads for West Burton Power Station added from 1973/76	Increase in number of houses adjacent to access routes in North Leverton / Sturton-le-Steeple.

1980s to present	No significant changes.	No significant changes.
EAST		
Dates	**On-Site**	**Off-Site**
1885/1886	Generally, site is arable farmland with access road layout and drainage layout much as present day. Significant drainage channels include Catchwater Drain and Mother Drain. Some ponds shown across the area. Littleborough Road with "Littleborough House" on north side of road near centre. Eastern bio-mitigation areas comprise arable farmland / bank of River Trent with "Towing Path" for barges on river.	North: Arable farmland. East: Hamlet of Littleborough & River Trent. South: Arable farmland. West: Arable farmland with hamlet of Fenton and village of Sturton-le-Steeple beyond.
1920s	Field sizes increasing due to removal of fences/hedges.	No significant changes.
1960s/1970s	No significant changes on majority of site (PV ARR-1-7 etc.). West Burton Power Station (ACC_CAB_AREA-1, CAB-ROU-1-3) with transformer building, several tanks, pylons and overhead power lines and access roads present by 1971 (not present 1951, presumed built in 1960s). Flood bank and pond (possible mineral extraction) within Bio-mitigation area near River Trent.	Increase in number of houses adjacent to access routes in Fenton and Sturton-le-Steeple. West Burton Power Station: (ACC_CAB_AREA-1, CAB-ROU-1-3) with access roads, boilers, chimneys, cooling towers, cooling ponds, coal and ash stocking yards, multiple tanks, pylons and overhead power lines shown by 1971 (not present 1951, presumed built in 1960s). Pylons and overhead power lines (all areas East).
1980s to present	No significant changes.	No significant changes.

3.2 Geology

WEST	
Made Ground	Made Ground is not recorded on the 1:10,000 or 1:50,000 BGS mapping. Made ground is present as road/track and railway embankments. It is considered that the road/track embankments will comprise locally excavated mudstone and clays with imported river gravels as the upper part of the embankment and forming the side lanes and tracks. The construction of the railway embankments is unknown (High House Road, bridge Mac3/207 is understood to date from 1849).
Superficial Geology	Superficial deposits are limited in extent and comprise localised head and alluvial deposits relating to the deeper stream valleys.
Solid Geology	The predominant unit beneath this area is the Mercia Mudstone Group (MMG) strata which typically comprises red brown, locally grey mudstones with localised beds or "skerries" of dolomitic siltstone and/or dolomitic limestone. The memoir for this area also references the presence of thin beds of gypsum. Excavations on site are likely to encounter a thin cover of topsoil/subsoil (generally less than 0.5m) underlain by variably weathered mudstone/siltstone of the MMG, as observed locally during the site walkover survey. Deeper alluvium and head deposits are anticipated to locally overlie the same solid sequence.
BGS Borehole Records	A single borehole is recorded by the BGS in the Western area. The Sturton Borehole at NGR 478595mE, 383031mN, to a depth of 1247m bgl (1976) proved: Mercia Mudstone Group (to 148.2m bgl), below which lie Sherwood Sandstone, Upper Permian Marl, Upper Magnesian Limestone, Middle Permian Marl, Lower Magnesian Limestone, Lower Permian Marl, Basal Permian Sands and Carboniferous Coal Measures.
Faults	None recorded on or immediately adjacent to the site.
Quarrying And Mineral Extraction	No evidence of quarrying within the site area although a clay pit is shown immediately north of Wheatley Road and other clay pits may have existed in this area. The site is not within an area affected by coal mining or other mineral extraction.

EAST	
Made Ground	Made Ground is not recorded on the 1:10,000 or 1:50,000 BGS mapping of the area. Made ground is present as road/track embankments. It is considered that the road/track embankments will comprise locally excavated mudstone and clays with imported river gravels as the upper part of the embankment and forming the side lanes and tracks. Made ground from the construction of the West Burton Power Station is anticipated across this area of the proposed cabling route in the extreme NW of the East area.
Superficial Geology	The entire area is anticipated to comprise alluvium over river terrace deposits. Localised areas of Glaciofluvial and Glacial Till Deposits are anticipated in the northern area (proposed BESS / existing Power Station). Superficial deposits comprise the following BGS units: • ALV-XCZSV Alluvium - Clay, Silt, Sand and Gravel • HPSG-XSV Holme Pierrepont Sand and Gravel Member - Sand and Gravel • GFDMP-XSV Glaciofluvial Deposits - Sand and Gravel • TILMPDMTN Till– Diamicton The presence of high of very high plasticity, high or very high volume change potential soils and the presence of compressible organic soils including peat should be anticipated.
Solid Geology	Predominantly strata of the Mercia Mudstone Group (MMG). Shallow mudstone bedrock observed in drain on North Side of Common Lane.
BGS Borehole Records	Twelve boreholes are recorded by BGS in East area. 2 No. boreholes are confidential. 10 No. borehole available records extend to depths of 3 - 1301.15m bgl. In summary, in this low-lying area there is typically a thin layer of topsoil and alluvial clays and sands with localised organic soils including peat to 7m bgl. River terrace deposits comprising sands and gravels extend to rockhead across the majority of the site at between 4.5m and 15.6m bgl (based on a limited number of boreholes). Bedrock is noted to be weathered to firm or stiff clay in a number of locations, becoming “hard” with depth.
Faults	None recorded on or immediately adjacent to the site.

Quarrying and Mineral Extraction	BritPits records identify a single sand pit on site – Blackburn Lane Sand Pit, Sturton-le-Steeple, Retford. The exact location has not been determined. There is a pond adjacent to the River Trent in the eastern edge of the site in BIO_MIT-4, which may have been used as a borrow pit to form the adjacent Flood Bank in this area as they are both shown on the 1970s maps of this area.

3.3 Hydrology and Hydrogeology

Water Courses	**West** Several streams, including Oswald's Beck and unnamed streams flow from West to East across the PV_ARR areas and are supplemented by drains adjacent to roadways and coming from the Sheffield to Lincoln railway embankment. **East** River Trent (tidal), lies immediately East of Environmental Mitigation areas to East at or very close to river bank levels of approximately 3m AOD. Numerous drainage channels, principally "Mother Drain" and "Catchwater Drain" are present across the Eastern part of the site. Water levels were approximately 2-3m below ground level at the time of the site walkover.
Flood Risk	A flood risk analysis is being undertaken by others and is therefore outwith the scope of this report.
Groundwater Classification	**West** <u>Superficial Geology</u> Limited superficial geology is present and is classed as Secondary Undifferentiated Aquifer. Superficial deposits identified as Head - Clay, Silt, Sand and Gravel. <u>Solid Geology</u> Mercia Mudstone bedrock generally Secondary B Aquifer with dolomitic siltstones classed as Secondary Undifferentiated Aquifers. 49 groundwater vulnerability records on site indicating superficial aquifer and productive bedrock aquifer with well connected fractures of high vulnerability. Soluble rocks are not identified, however there is the potential for localised soluble rocks in the dolomitic siltstones. The site does not lie within a nitrate sensitive zone. The site lies within 2000m of 9 Nitrate Vulnerable Zones, 2 of which are identified as being "on-site" as follows: • Catchwater Drain catchment (trib. of Trent) NVZ Surface Water 344 Existing

	• Wheatley Beck Catchment (trib. of Trent) NVZ Surface Water 345 Existing **East** <u>Superficial Geology</u> Extensive superficial geology is present and is classed as Secondary A Aquifer. Superficial deposits identified as Alluvium / River Terrace deposits and Glacial Till comprising - Clays, Silts, Sands and Gravels. <u>Solid Geology</u> Mercia Mudstone bedrock is generally classified as a Secondary B Aquifer with dolomitic siltstones classed as Secondary undifferentiated aquifers. 22 groundwater vulnerability records on site indicating productive superficial aquifer and productive bedrock aquifer with well connected fractures of high vulnerability. NB: BESS Area does not have a significant cover of superficial soils. Soluble rocks are not identified, however there is the potential for localised soluble rocks in the dolomitic siltstones. The site does not lie within a nitrate sensitive zone. The site lies within 2000m of 17 Nitrate Vulnerable Zones, 3 of which are identified as being "on-site" as follows: • Seymour Drain Catchment (trib. of Trent) NVZ Surface Water, 343 Existing • Catchwater Drain Catchment (trib. of Trent) NVZ Surface Water, 344 Existing • R. Trent from Carlton-on-Trent to Laughton Drain NVZ Surface Water, 347 Existing
Licensed Surface Water Abstractions	**West** 7 No. licensed surface water abstractions are recorded within 2000m of the site. None on site. **East** 13 No. licensed surface water abstractions are recorded within 2000m of the site. 1 No. on site, historical record of abstraction 03/28/69/0186, direct spray irrigation of fields from Cottam – Mother Drain, "Warburton" NGR 482130, 381950, 25000m³/yr, <960m³/day.
Licensed Groundwater Abstractions	**General** No groundwater abstractions recorded within 2000m. The site does not lie within 500m of a groundwater source protection zone.
Springs / Wells	**West** Numerous springs and wells can be identified from the Ordnance Survey mapping of the area.

	East No springs or wells identified.
Water Network (OS Mastermap)	**West** 72 records on site (some duplicates) referring to non-tidal watercourses mainly on surface (or in channels) with some underground (e.g. culverts) - where Watercourse contains water year round (in normal circumstances) **East** 128 records on site (some duplicates) referring to non-tidal watercourses mainly on surface (or in channels) with some underground.
Discharge Consents	**West** 3 No. relating to High Sturton House, "Sewage & Trade Combined – Unspecified", Permit DT/6964. The location appears to be within site but lies outside the application area. **East** 1 No. relating to site area. Rampton Manor, Rampton, Retford, Midlands, DN22 9HF, Effluent Type: sewage discharges - pumping station discharge company, Permit Number: TSC3799, Permit Version: 1, Receiving Water: local ditch, Status: varied under EPR 2010, Issue date: 03/09/2010, Effective Date: 03/09/2010, Revocation Date: 12/08/2011.
Pollution Incidents	None recorded within 500m.

3.4 Landfill and Waste Management

Landfill Records	**West** No active or recent landfill sites within 500m. No BGS landfill records within 500m. No EA landfill records within 500m. **East** No active or recent landfill sites within 500m. No BGS landfill records within 500m. 2 No. EA landfill records within 500m: Understood to relate to Bole Ings Site – Storage of Pulverised Fuel Ash (PFA) on NE side of power station. 2 No. Licensed Waste Sites 385m NE. Bole Ings Site within West Burton Power Station. Type of Site: Industrial Waste Landfill (Factory curtilage) Size: >= 75000 tonnes Environmental Permitting Regulations (Waste) Licence Number: EDF001. EPR reference: - Operator: E D F Energy (West Burton Power) Limited Waste Management Licence No: 43109, Annual Tonnage: 3000, Issue Date: 01/04/1996 Effective Date: 03/06/2005
Other Waste Transfer, Treatment or Disposal	**West** No Waste Transfer Sites within 500m. 16 No. Waste Exemptions for storage of sludge on farms, on site. **East** Pollution inventory waste transfers: 1 No. waste transfer within 500m, none on site. 25 No. (15 locations) Waste Exemptions for storage of sludge on farms, on site.

3.5 Industrial Land-use, Environmental Licences, Permits and Registers

Recent/current Industrial Land Use	**West** 3 No. recorded on site: • Electrical Sub-Station • Electricity Pylons • Water Pumping Station **East** • West Burton Power Station on site • 2 No. references to 'tanks' on site, immediately NW of West Burton Power Station transformer building from 1976 to present day (Google Earth) • Multiple references to 'tanks' and 'unspecified tanks' off site within 250m (some duplicated) to the North and North West within West Burton Power Station • Electrical Pylons on site
Recent/current Petrol Stations	None recorded on site.
Part 2A Designated Contaminated Land	None recorded on site.
COMAH/Regulated Explosive Sites	**West** 1 No. within 500m, West Burton Power Station (EDF Energy (Thermal Generation) Ltd) **East** West Burton Power Station (EDF Energy (Thermal Generation) Ltd) on site
Historical IPC Authorisations	None recorded on site.
Part A (1) and IPPC Authorised Activities	**West** None recorded within 500m. **East** 21 No. recorded within 500m relating to West Burton Power Station but none shown on site.
Red List Discharge Consents (potentially harmful discharges to controlled waters)	None recorded on site.

List 1 and List 2 Dangerous Substances Inventory Sites	None recorded on site, but several are listed in power station.

3.6 Radon

The Groundsure report assesses radon risk using data supplied by Public Health England along with BRE Document 'BR 211 - Radon: Guidance on the Protective Measures for New Dwellings'. The report indicates that the site lies within an area where less than 1% of properties are above the Action level hence radon protective measures are not required.

3.7 Environmental Receptors

Designated Sites: SSSI, RAMSAR, SAC, SPA, NNR, LNR etc.	**West** None recorded within 2000m. **East** None recorded within 2000m.
Other Relevant Environmental Receptors	No ancient woodlands identified on site.
Scheduled Ancient Monument	**East** 2 No. within 250m: 1 No. on site, referring to Segelocum Roman Town which encroaches on the edge of the site near Littleborough. The boundary of this feature should be checked against development plans. It is anticipated that an archaeological watching brief will be in place in the vicinity.

4.0 Conceptual Site Model

4.1 Background

This assessment is designed to meet the requirements for preliminary environmental risk assessment as detailed within the 'Land contamination: risk management' (LCRM, Environment Agency, online) and 'Guidance for the Safe Development of Housing on Land Affected by Contamination' (R&D Publication 66: 2008). The latter guidance is particularly focussed on the development of housing on land affected by contamination. However, the advice is generally applicable to other forms of development and to sites where no development is proposed.

Risk to human health or environmental receptors is based on an assessment of one or more source-pathway-receptor linkages. The contaminant 'source' is any substance which has the potential to cause significant harm to a relevant receptor and the 'pathway' is any route by which the contaminant may travel to impact on a 'receptor'.

It should be noted that the proposed development will have no buildings which are to be occupied, so the human health contaminant exposure assessment considers the risks to construction workers and future maintenance workers of the proposed development.

The Conceptual Site Model (CSM) summarises the principal contaminant sources, pathways and receptors for this site and the likelihood of the existence of a plausible contaminant linkage. The assessment is based on the proposed end use of light industrial structures in the case of the BESS site.

Consideration is also given to the presence of the underlying aquifers which must be protected from leaks of contaminants during construction and from site operations.

4.2 Contaminants of Concern

The site history indicates no potential significant contaminative processes have operated on the majority of the site, where 99% of the proposed development land area is arable farmland, but there are localised sources such as the power station area and the storage of farm slurry, application of sewage sludge to the farmland, farm equipment, storage and application of biocides and possible storage of farm fuels.

The following contaminants of concern may be anticipated on site in areas currently occupied by farm buildings, railways embankments/cuttings, West Burton Power Station and the buried oil pipelines, for which the full list is presented in Appendix E. Although now withdrawn, reference has also been made to the Department of Environment (DoE) 1995 Industry Profiles for 'Railway Land' and 'Power Stations (excluding nuclear power stations)', which form useful terms of reference for contaminants of concern.

- General: PAHs, metals and metalloids, water soluble sulphates, asbestos containing materials (ACMs), such as asbestos/cement cladding, heating oil hydrocarbons, fuels, lubricating oils, biocides, animal effluent and feed storage.

- Railways: PCBs, PAHs, coolants (e.g. ethylene glycol), timber preservatives, herbicides, ferrous residues, metal fines and sulphides.

- Power Station and oil pipelines: PAHs, PCBs and other transformer oils, gas oil, metals, metalloids and their compounds, lubricating oils, water treatment chemicals, ACMs and timber treatment chemicals.

- Farming: PAHs, metals and metalloids (tracks/hardstanding), water soluble sulphates, asbestos containing materials (ACMs), heating oil hydrocarbons, fuels, lubricating oils, biocides, animal effluents and wastes storage, biocides.

- Sewage sludge applied to farm fields: PAHs, inorganics including water soluble sulphates, chlorides, ammoniacal compounds and nitrogenous derivatives, metals and metalloids, hydrocarbons and PFAS (per- and polyflouralkylated substances).

There are no significant off-site sources of potential soil or groundwater contaminants that could give rise to harm to the proposed end users of the site.

Consideration should be given to the potential presence of elevated sulphate and chloride within the Mercia Mudstone deposits beneath the West area of the site in particular and potential aggressivity to in-ground built elements.

4.3 Ground Gas Risk

Any made ground, infilled ground and natural alluvial deposits can provide a generally low volume source of ground gas.

There is low risk potential for ground gas generation due to decay or organic soils within the alluvial deposits on the East side of the site.

4.4 Phase 1 CSM and Preliminary Environmental Risk Assessment

The significance of the potential source-pathway-receptor linkages identified in the CSM is assessed using the following criteria:

Low Risk
Not likely to cause significant harm to human health or controlled waters. Remedial measures are unlikely to be required.

Moderate Risk
Possible significant harm to human health or controlled waters could occur depending on site specific circumstances. Remedial measures may be required.

High Risk
It is likely that significant harm to human health or controlled waters will occur unless appropriate remedial measures are incorporated into the development.

Conceptual Site Model and Preliminary Environmental Risk Assessment

Source	Pathway	Receptor	Contaminant Linkage: Assessed Risk
Human Health			
<u>Greenfield Areas (99% of area)</u> Potential contaminants within the farmland: PAHs, heavy metals, water soluble sulphates and chloride, ammoniacal compounds and nitrogenous derivatives, biocides and PFAS.	Direct contact and ingestion/inhalation of contaminated soil and dust.	Construction workers	**Low** Mitigated by controlled removal of, any proven contaminants prior to construction. Use of appropriate PPE and good site hygiene practice during construction.
	Direct contact and ingestion/inhalation of contaminated soil and dust.	End users, future maintenance workers	**Low** Mitigated by controlled removal of, or provision of effective barrier to, any proven contaminants prior to end use.
<u>Brownfield Areas (1% of area)</u> Potential contaminants within farm buildings, railway lines, power station and oil pipelines: PAHs, PCBs, heavy metals, water soluble sulphates, hydrocarbons, biocides and ACMs.	Direct contact and ingestion/inhalation of contaminated soil and dust.	Construction workers	**Moderate** Mitigated by controlled removal of, or provision of effective barrier to, any proven contaminants prior to construction. Use of appropriate PPE and good site hygiene practice during construction.
	Direct contact and ingestion/inhalation of contaminated soil and dust.	End users, future maintenance workers	**Low to moderate** Mitigated by controlled removal of, and/or provision of effective barrier to, any proven contaminants prior to end use.
Off-site sources of soil or groundwater contaminants	No significant plausible sources, so no pathways.	End users, future maintenance workers	**Low** No mitigation required.
Ground gas associated with underlying organic matter (low lying Eastern Areas)	Limited number of structures relating to BESS and substations. Unlikely to be in areas where organic soils are present.	End users, future maintenance workers	**Low** No mitigation required.

Controlled Waters			
<u>Greenfield Areas (99% of area)</u> Mobile and leachable contaminants within the made ground on site and from ameliorated natural soils.	Vertical and lateral migration to groundwater.	Secondary A Aquifer (drift) Secondary B Aquifer (bedrock) Surface Water: streams/drains and River Trent	**Low** No significantly leachable contaminants anticipated on site as little/no made ground is expected across this area, and any made ground is likely to be reworked natural soils and construction arisings, however, sources of diffuse pollution (e.g. sewage sludge ameliorated soils) exist on the farmland. No mitigation anticipated. **Low** Receptors unlikely to be affected by the development from existing potential low risk diffuse contaminant sources. No mitigation anticipated.

<u>Brownfield Areas (1% of area)</u> Potential mobile and leachable contaminants within farm buildings, railway lines and power station: PAHs, PCBs, heavy metals, water soluble sulphates, hydrocarbons, biocides and ACMs. Mobile, free phase and dissolved contaminants from historic and current tanks on and nearby off-site at West Burton Power Station and buried oil pipelines.	Vertical and lateral migration to groundwater.	Secondary A Aquifer (drift) and Secondary B Aquifer (bedrock)	**Low to moderate** The Power Station land previously undeveloped so made ground is expected to be reworked natural soils and construction arisings, and limited made ground in farmyard and railway areas, so significant leachable contaminants are not anticipated. Mitigation: remove/treat any contaminants, replace with clean soil backfill around cabling routes and/or provide physical barrier to prevent leaching of soil contaminants, e.g. hard cover. **Moderate** Tanks within power station development area and off-site nearby may be point sources of mobile contaminants, and linear sources of oil pipelines, can create free phase and dissolved contaminant plumes in the aquifers. Shallow (<1m) depth of dig for much of the cabling routes unlikely to encounter such contaminants, however, horizontal directional drilling (HDD) to avoid existing buried infrastructure (e.g. oil pipelines) may locally reach water table contaminants. Mitigation: identify leaking/leaked point sources and remove/repair, and/or remove/treat any contaminants, replace with clean soil backfill around cabling routes and/or provide physical barrier to any residual contaminants, e.g. protective cable sheathing, clay fill surround and/or hard cover, over affected parts of cable routes.

<u>Greenfield Areas (99% of area)</u> Mobile and leachable contaminants within the made ground on site.	Via surface water run-off and lateral migration via groundwater discharging into surface water bodies.	Surface Water: streams/drains and River Trent	**Low** Farmland previously undeveloped so little or no historic made ground expected, and any made ground is likely to be reworked natural soils and construction arisings, so significant leachable contaminants not anticipated. Mitigation: Receptors unlikely to be affected by the development from existing potential low risk diffuse contaminant sources. No mitigation anticipated.
<u>Brownfield Areas (1% of area)</u> Potential mobile and leachable contaminants within farm buildings, railway lines and power station: PAHs, PCBs, heavy metals, water soluble sulphates, hydrocarbons, biocides and ACMs. Mobile, free phase and dissolved contaminants from historic and current tanks on and nearby off-site at West Burton Power Station.	Via surface water run-off and lateral migration via groundwater discharging into surface water bodies.	Surface Water: streams/drains and River Trent	**Moderate** Power Station land previously undeveloped so little historic made ground expected, and is likely to be reworked natural soils and construction arisings, and limited made ground expected in farmyard and railway areas. Oil pipelines expected to be monitored for leak detection, so low risk of significant leakage. Historic tanks may have been less well controlled. Significant leachable or contaminants not anticipated, but mobile/free phase contaminants may exist locally. Mitigation: identify leaking/leaked contaminant sources and remove/repair, remove/treat any contaminants, replace with clean soil backfill around cabling routes and/or provide physical barrier to soil contaminants, e.g. hard cover.

5.0 Conclusions and Recommendations

The following assessment should be considered as preliminary until it can be verified by further site-specific data from a suitably designed targeted ground investigation for the proposed development.

The investigation will primarily acquire geotechnical data necessary for foundation design and excavation of the cable route through shallow bedrock.

5.1 Contaminants of Concern and Remediation

The presence or not of the stated potential contaminants of concern should be assessed by sampling the topsoil, subsoil to be re-used and any made ground encountered. Where mobile or leachable significant contaminants are present, groundwater sampling should also be undertaken and associated sampling of any potentially affected nearby watrcourses. Where HDD is proposed benath crossing points of existing buried infrastructre, advance groundwater sampling from groundwater monitoring wells adjacent these features should be undertaken. Made ground soil contaminant analysis should be underatkn along the line of the cable routes within the Power Station area.

Excavation for foundations, cable routes and construction of improved access routes will potentially include excavation of the shallow mudstone bedrock in the Western area. Mercia Mudstone is identified in BRE SD1:2005 “Concrete in Aggressive Ground” as having the potential for high sulphate and chloride (in Halite) contents.

The results of the chemical testing should be subject to risk assessment using published generic assessment criteria (GACs) for the ‘industrial/commercial end use’ and following this, soil re-use and/or remediation mitigation measures can be considered, if required.

5.2 Ground Gas

The open nature of the site and proposed works with a lack of fixed buildings precludes the general risk of gas accumulation. It is understood that containers at the BESS Site are to be raised above ground to avoid water ponding, which will also assist in preventing ground gas and radon accumulation and entry into these structures. The BESS is anticipated to lie outwith the low lying areas most at risk from decay of organic matter.

Radon protective measures are not required for buildings to be occupied in this area.

5.3 Drainage

The shallow bedrock may be suitable for soakaway drainage systems, subject to groundwater levels and infiltration testing. However, it should be noted that all bedrock is considered to be high vulnerability and locally with potentially soluble mineralogy.

Proposed surface water attenuation basins and/or soakaway drainage systems should be situated at safe recommended distances from the foundations of any permanent structures, e.g. the BESS and the Solar PV Array frames.

5.4 Recommendations for Ground Investigation

A ground investigation will be required prior to development to assist in terms of engineering design. However, as the site is deemed as being of low overall risk of having significant contamination, it is not considered necessary to undertake the ground investigation prior to grant of planning.

To establish the environmental risk based on the findings of the CSM, the following further assessment works are recommended:

- Phased Ground Investigation prior to development.
- Intrusive ground investigation to depths of the order of 5m with in-situ testing and sampling of soils for BESS and Cable Infrastructure areas – principally to identify presence of shallow soil and/or groundwater contaminants (as deemed necessary and appropriate during the course of the investigations) and underlying foundation conditions.
- Trial pitting for in-situ testing, sampling and rock mass assessment for: Cable Access Route and Solar PV Array foundations. These pits will allow for costing and programming of the cable excavation and foundation design, together with assessment of the suitability of the excavated soils and rock for re-use on or off site.
- In-situ CBR testing of internal access tracks and roads for road design parameters
- In-situ pile pull-out tests for PV mounting frame system foundation design.
- Infiltration testing to determine the suitability of the bedrock and to obtain the parameters for soakaway drainage design (subject to review of options for surface water disposal away from PV Array foundations).
- Geotechnical laboratory testing of the soils to assess the physical and geochemical properties. e.g. water soluble sulphate, chloride and pH, electrical resistivity, natural moisture content, particle size distribution, maximum dry density/optimum moisture content relationship and LA coefficient.
- Chemical laboratory testing of soils and groundwater/surface water as necessary based on historic land use in each location and field observations to validate the findings of the CSM and enable a generic quantitative risk assessment to be carried out by comparison against the industrial/commercial end-use criteria. Parameters to include the potential contaminants of concern within the made ground on site in areas of farmland, farm buildings, railway lines, power station and buried oil pipelines: PAHs, PCBs, heavy metals, water soluble sulphates, inorganics, hydrocarbons, biocides, asbestos and PFAS.
- Factual and interpretive report, providing recommendations for remedial actions as required to allow the safe development of the site.

Appendix A

Drawings

Appendix B

Historical Maps

WEST

Western Area Small Scale Maps (1:10,000 / 1:10,560 Scale) – G-24-030-WEST-SMALL.ZIP

Western Area Large Scale Maps (1:2,500 Scale) – G-24-030-WEST-LARGE.ZIP

Western Area Landline Maps (1:1,250 Scale) – G-24-030-WEST-LANDLINE.ZIP

EAST

Eastern Area Small Scale Maps (1:10,000 / 1:10,560 Scale) – G-24-030-EAST-SMALL.ZIP

Eastern Area Large Scale Maps (1:2,500 Scale) – G-24-030-EAST-LARGE.ZIP

Eastern Area Landline Maps (1:1,250 Scale) – G-24-030-EAST-LANDLINE.ZIP

Appendix C

Environmental Data

Groundsure – Environ+Geo Insight Reports

Sturton-le-Steeple (West)	Report GS-LSP-DYZ-NTQ-1YC
Sturton-le-Steeple (East)	Report GS-4FX-9DA-ZQ2-EPN

Appendix D

Site Walkover Photographs

Site Walkover Photograph Location Plans – West	Dwg No. G-24-030-005
Site Walkover Photograph Location Plans – East	Dwg No. G-24-030-006
Site Walkover Photographs	Fig.1 to Fig.66

Appendix E

Potential Contaminants of Concern

POTENTIAL CONTAMINANTS AND PRINCIPAL LOCATIONS

Based where available on available Department of Environment (DoE) Industry Profiles, originally published in 1995 and withdrawn in 2014.

1. **Railway Land**

   PCBs, PAHs, ethylene glycol, creosote, biocides, ferrous residues, metal fines, ash, sulphide.

2. **Power Stations (excluding nuclear power stations) and Oil Pipeline**

   Raw Materials Delivery/Storage: Lubricating Oils, Water Treatment Chemicals.

   Fuel Storage/pipework: coal, fuel oil and gas oil.

   Process Buildings: lubricating oils, asbestos, solvents.

   Drainage System: water treatment chemicals.

   Electricity Transformer Areas: PCBs and other transformer oils.

   Waste disposal areas (Ash Lagoons): metals, metalloids and their compounds, lubricating oils, water treatment chemicals, asbestos and timber treatment chemicals.

Not included in DoE Industry Profiles

3. **Farming**

   Farmyards: PAHs, metals and metalloids (tracks/hardstanding), water soluble sulphates, asbestos containing materials (ACMs), heating oil hydrocarbons, fuels, lubricating oils, biocides, animal effluent and feed storage.

   Fields: biocides, feed/animal waste storage.

   Access Roads: PAHs, metals and metalloids, sulphates, ACMs.

   Sewage sludge applied to farm fields: PAHs, inorganics including water soluble sulphates, chlorides, ammoniacal compounds and nitrogenous derivatives, metals and metalloids, hydrocarbons and PFAS (per- and polyflouralkylated substances).